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# Research

EDUCATION



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## PECASE: AFOSR-Funded University Researchers Receive Presidential Award

**T**wo researchers sponsored by the Air Force Office of Scientific Research were awarded the prestigious Presidential Early Career Awards for Scientists and Engineers March 3, 2000.

This award is the highest honor bestowed by the U.S. government on young professionals who are at the outset of their independent research careers. The award includes a five-year, \$500,000 research grant.

The two, Drs. Jeffrey Borggaard of Virginia Tech and Kathryn Moler of Stanford, were recognized for their efforts in conducting top quality research in areas of critical importance to the Air Force.

"These researchers have made important contributions to the science and technology needs of the Air Force," said Dr. Joe Janni, director of the Air Force Office of Scientific Research.

Dr. Borggaard, an Assistant Professor of Mathematics at Virginia Tech, received his doctorate in mathematics from Virginia Tech in 1995.

"Dr. Borggaard's work on continuous sensitivity equation methods for nonlinear partial differential equations has produced new and powerful computational tools with wide

applications to the design, control, and optimization of aerospace systems," said Dr. Marc Jacobs, program



Dr. Kathryn Moler



Dr. Jeffrey Borggaard

manager in AFOSR's Directorate of Mathematics and Space Sciences.

"For the Air Force, this work provides the foundation for new software that can reduce design cycle times from years to weeks. The payoffs are exciting applications to the design of aerospace vehicles, optimization of propulsion systems, and the control of aerodynamic flows," he continued.

Dr. Kathryn Moler, an Assistant Professor of Applied

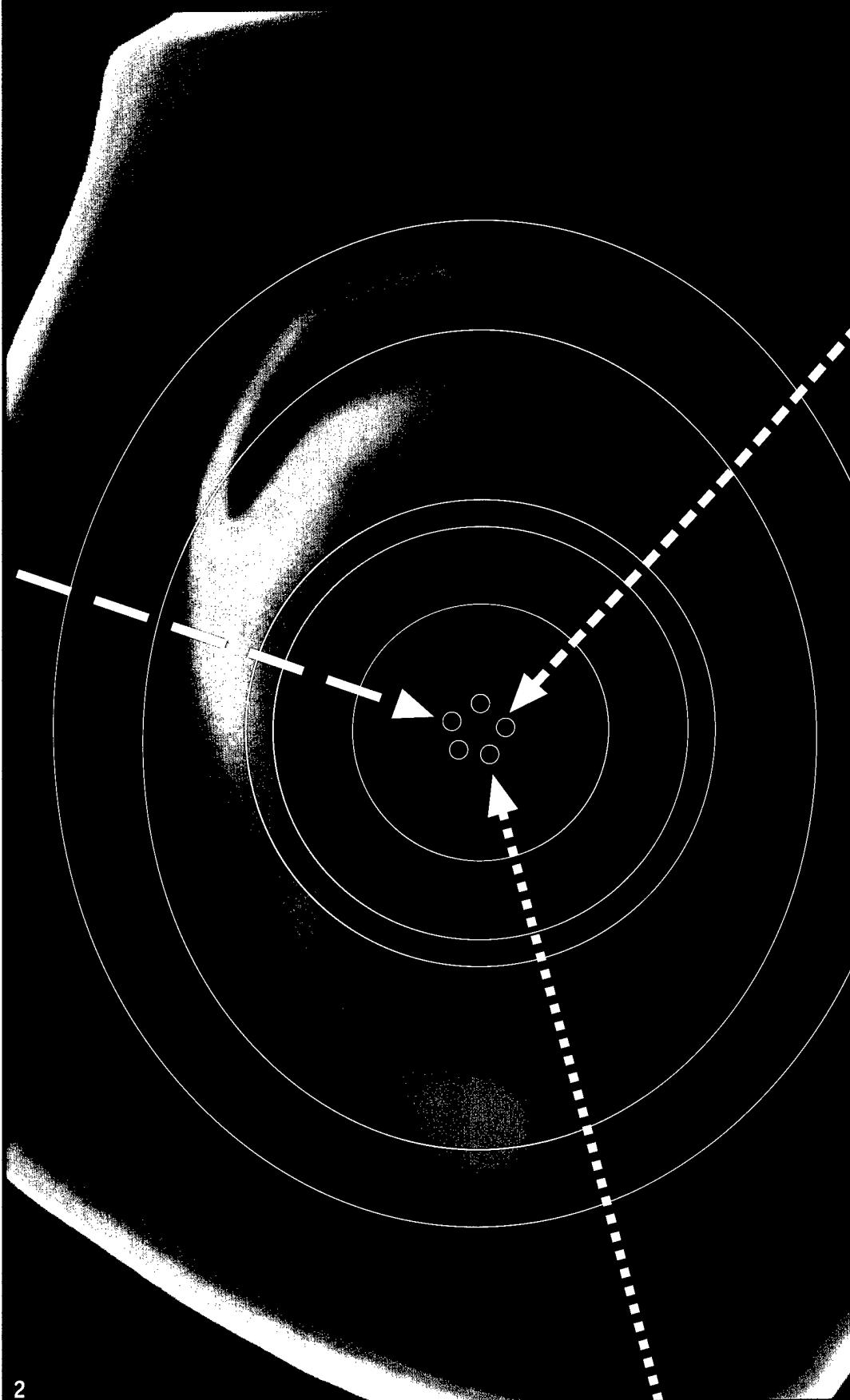
Physics at Stanford also received the PECASE award for her efforts on behalf of the Air Force. She received her doctorate in physics from Stanford in 1995.

"Professor Moler's research on nanomagnets has the potential to create a data storage medium of unprecedented density, possibly as dense as 1,000 Gbits per square inch, compared to today's best technology which offers 10 Gbits per

*story continued on page 3...*

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# INFORMATION OVERLOAD: Researchers Des



**I**nformation overload" is an ever-increasing concern for human performance, both in and outside the military environment. In air and ground operations, the sheer amount and complexity of information can exceed the amount a person can comprehend, especially in high-tempo, critical missions.

One type of information overload stems from the necessary use of headphones in aircraft and in many ground command-and-control stations. Headphones bring remote, multiple communications directly to the ear. They reduce background noise and thereby increase the signal-to-noise ratio. But there is a cost — every sound in a headphone emanates from the same point in space, just outside the ear. If two, three, or four voices or other signals are heard at once, it can be extraordinarily difficult to sort them out. Richard McKinley's research at Wright-Patterson AFB has shown that such auditory congestion can make it impossible for headphone wearers to understand what is being said to them.

In ordinary, headphone-free listening, the human brain clears away much of the auditory congestion by identifying sounds according to their positions in space. This ability to attend selectively to regions in auditory space is often called the "cocktail party phenomenon." In a room crowded with talkers, a person can listen rather selectively to one conversation, then another, and another, without moving about the room. The

# gn "Virtual" Auditory Space

gist of several superimposed conversations can be understood because the human auditory system can focus on sounds coming from specific directions. With headphones, such selective listening can be difficult or impossible.

Researchers in AFRL's Human Effectiveness Directorate, in collaboration with Dr. Barbara Shinn-Cunningham of Boston University, have made important strides in solving this problem for headphone users. The goal is to create headphone-based auditory displays in which each sound source has a well-defined position in three-dimensional space. The first step is to isolate the various electronic signals reaching a headphone so that each communication occupies one channel in a multi-channel system.

The next step is to modify the acoustic waveform at the ear so that, to the listener, each communication appears to originate from a separate, nearby location, rather than from the headphones. To create this 3-D auditory illusion, Dr. Shinn-Cunningham and AFRL's Dr. Douglas Brungart have collaborated on a detailed study of how people decipher the direction and distance of ordinary sounds in various 3-D environments. Using data from their extensive laboratory studies, along with mathematical models of directional hearing, these scientists have developed ways to transform the acoustic waveform to "convince" the human brain that a sound or voice emanates from almost any desired spot in a room or cockpit.



Dr. Barbara Shinn-Cunningham

Potential applications abound. For example, a pilot could hear the AWACS controller speak from one consistent position in the cockpit, while the navigator always speaks from another. Signals from the ground could appear to come below. Signals from another aircraft could correlate with the craft's actual position. An "auditory pointer" could guide visual attention to an important instrument in the cockpit. The same technology could be adapted to improve directional awareness for hearing-aid users. In each case, the goal is to harness direction-selective listening to increase human information-processing capacity.

"There would be no hope for these technological innovations without a very concerted effort to find out how directional hearing actually works," observes Dr. Willard Larkin, who is the Program Manager for the project. "Basic research is the indispensable key."

## Rokhlin – In The News...

A prestigious publication in the scientific community recently recognized the efforts of an AFOSR-sponsored researcher by including his work in its "Top" lists.

The Fast Multipole, or FM, method of Dr. Vladimir Rokhlin of Yale's Dept. of Computer Science was included in Computing in Science and Engineering magazine's Top 10 Algorithms of the Century. His FM method (1987) is cited for its revolutionary impact on the gravitational or electrostatic N-body problem.

Recently, under AFOSR and DARPA sponsorship, Dr. Rokhlin has successfully extended his FM method to revolutionize the numerical prediction of the scattering of electromagnetic waves (radar) from large, electromagnetically complex objects. The Air Force has long wished to document the radar signatures of a variety of existing objects (theirs and ours) as well as predict the radar signatures of a variety of contemplated objects and to do both of these jobs under a variety of possible conditions/configurations. But until the FM extension, the existing numerical codes for these large, electromagnetically complex objects took months to complete a single run. Run times of less than 12 hours are now being reported for current research codes, and transition to industrial strength codes is not far off.



Dr. Vladimir Rokhlin

## PECASE (cover story)

*Continued from page 1*

square inch. Other possible applications of her research include quantum computing and biomolecule detection," said Dr. Harold Weinstock, program manager in AFOSR's Physics and Electronics directorate.

These presidential awards, established by President Clinton in 1996, embody the high priority the Administration places on producing outstanding scientists and engineers and nurturing their continued development. Eight federal departments join together annually to nominate the most meritorious young scientists and engineers who will advance science and technology that will be of the greatest benefit to the participating government agencies.

**This award is the highest honor bestowed by the U.S. government on young professionals who are at the outset of their independent research careers.**

# ESEP ProFiles

The DoD Engineer and Scientists Exchange Program, or ESEP, supports science and technology through international cooperation in military research, development, and acquisition through the exchange of defense scientists and engineers. ESEP provides on-site assignments for U.S. military and civilian scientists and engineers in foreign government organizations and reciprocal assignments of foreign scientists and engineers in U.S. government organizations. ESEP supports current USAF science and technology requirements by seeking specific foreign technologies. It provides insight into the technology and project management techniques of foreign laboratories and centers and opens areas of possible technical cooperation.

## Capt. Philip Cali

Air Force Research Laboratory  
Aerospace Vehicles Directorate



Capt. Philip Cali

### Education:

MS in Aeronautical Engineering, MIT  
BS in Aerospace Engineering, Syracuse

### Current Assignment:

Office National d'Etudes et de Recherches Aerospatiale (ONERA), Chatillon Cedex France, near Paris

### Description of Work:

Captain Cali is working at Onera in the field of Computational Fluid Dynamics, or CFD. Briefly, CFD is the science of simulating the flow field in the vicinity of a body in motion. Modern CFD software packages simulate fluid flow properties using a mesh of grid points to represent the continuous physical domain around the body of interest. In order to facilitate constructing high quality meshes about complex geometries, the physical domain is often partitioned into separate regions (usually on a component basis) and individual grids are generated in each region. His current research is focused on improving the manner in which neighboring grids communicate. His approach, which is applicable to any CFD code, has been employed to augment the accuracy and efficiency of a production CFD software package developed at Onera. For a more detailed description of his work to date, please contact Captain Cali directly at [calipm@onera.fr](mailto:calipm@onera.fr) or reference his American Institute of Aeronautics and Astronautics paper number AIAA-2000-1008.

## Research Highlights

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*Research Highlights* is published every two months by the Air Force Office of Scientific Research. This newsletter provides brief descriptions of AFOSR basic research activities including topics such as research accomplishments, examples of technology transitions and technology transfer, notable peer recognition awards and honors, and other research program achievements. The purpose is to provide Air Force, DoD, government, industry and university communities with brief accounts to illustrate AFOSR support of the Air Force mission. *Research Highlights* is available on-line at:

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